General Interface Requirements

For

SNS Power Supplies

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January 4, 2001

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1.0 Scope

This document describes the interface to the SNS Power Supplies. It describes how the Control, Machine Protection System (MPS), Personal Protection System (PPS), and External Interlock System are connected to the power supplies.

Some of this document is applicable to the manufacture of the power supplies. Other parts are included to assist in the installation of the equipment.

2.0 Control Interface

2.1 Overview

The control interface consists of two elements, a Power Supply Controller (PSC) that resides in the control VME crate, and a Power Supply Interface (PSI) that resides in or near the power supply. These two elements are connected by a pair of fiber optic cables. The PSC can control up to six PSIs. This system is shown in Figure 1.

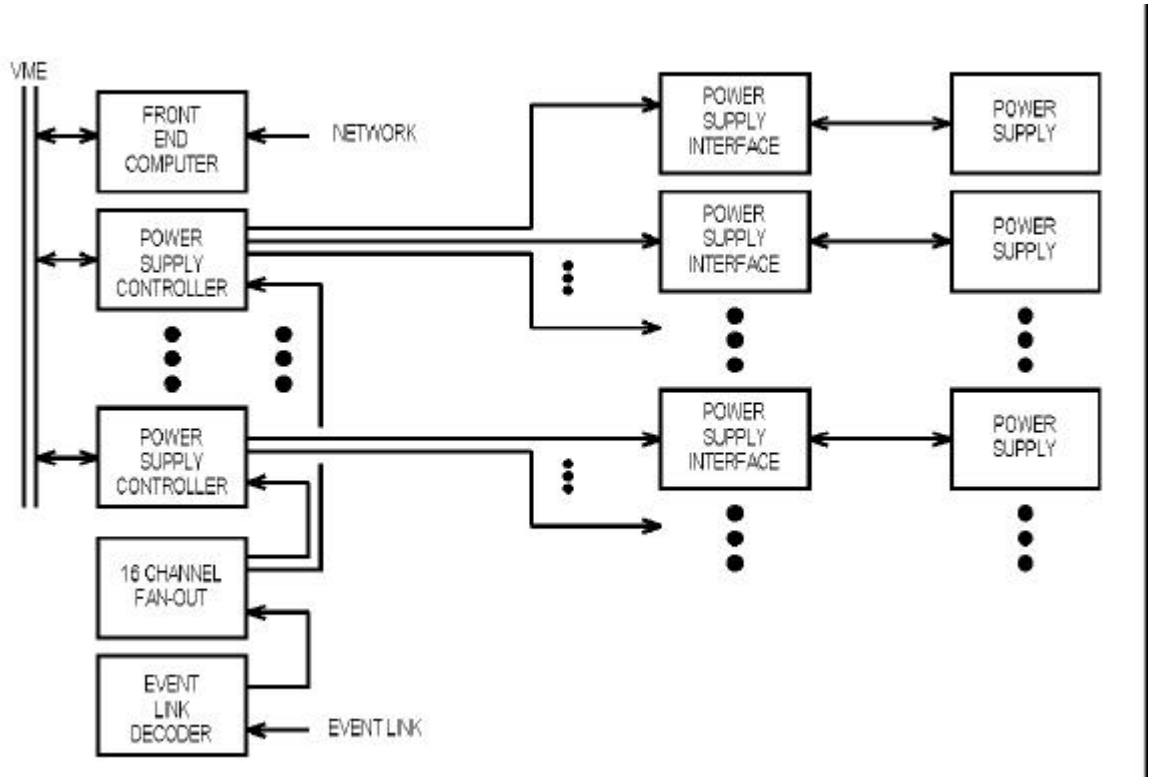

Figure 1 Control Interface

2.2 The PSI to Power Supply Connection

The power supply is connected to the PSI with two cables. One is for analog signals, the other for digital signals. The power supply manufacturer will typically supply these cables, but it is important that even the power supply end is as described here. Then, if a cable fails, it can be replaced with a standard spare.

2.2.1 Analog Cable

a) Analog Output - There is one analog output from the PSI to the power supply. This is typically used for the current setpoint. Depending on a jumper setting on the PSI, this may be either bipolar (±10V) or unipolar (10V). It is designed to be received differentially, and will drive loads whose resistance is 2KÙ or greater.

b) Analog Inputs - There are four analog inputs to the PSI from the power supply. These are typically used for current setpoint, measured current, measured voltage, and measured current. These are always bipolar (±10V). They are received differentially, with a load whose resistance is 2K Ù or greater.

c) Connectors - All connectors are nine pin standard D connectors, with gender as follows:

- On PSI: Male
- On PSI end of Cable: Female
- On Power Supply end of Cable: Female
- On Power Supply: Male

Connectors on both ends of the cable are to be supplied with strain relief back shells.

d) Pin Designations - The pin designations are given in Table 1, and the general arrangement is given in Figure 2.

e) Cable - An assembly of two separate cables, as seen in Figure 2, joins the connectors. One is a shielded twisted pair, and the other is a shielded twisted five conductor cable.

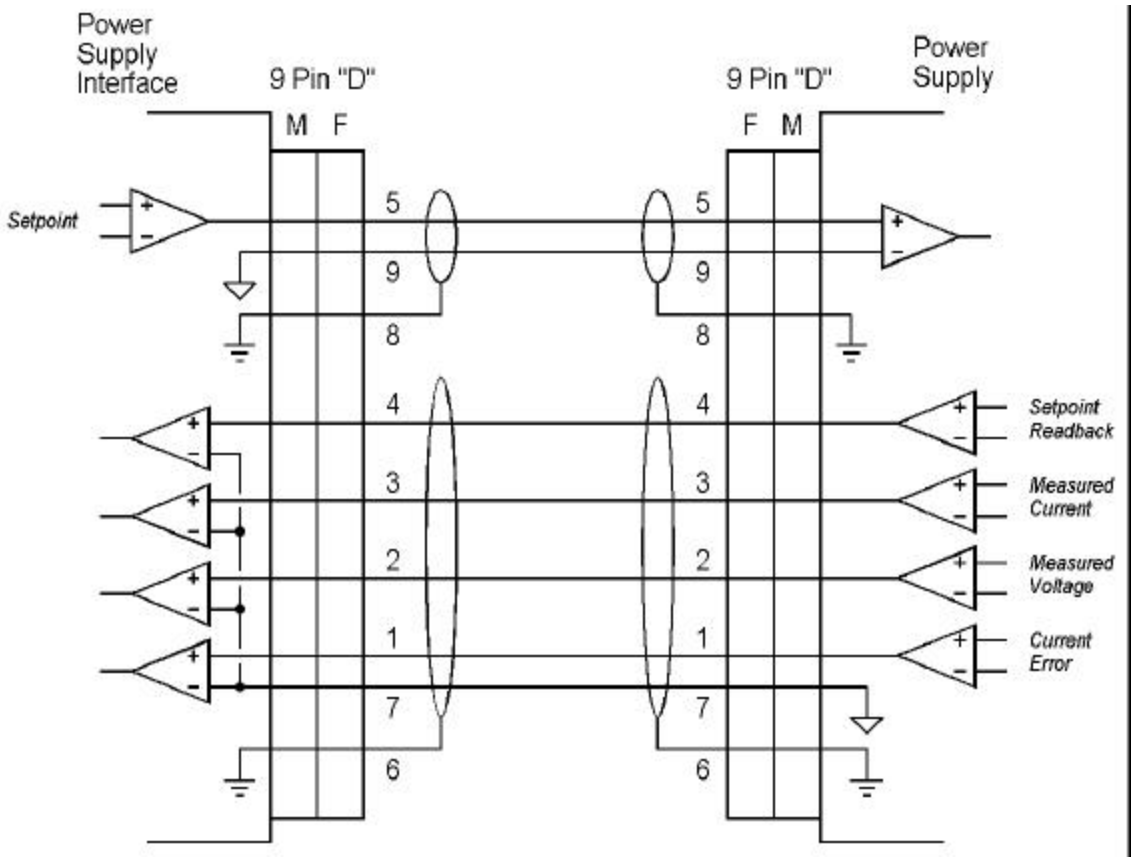

Figure 2 Analog Cable - General Arrangement

Table 1. Analog Cable Pin Designation

Pin	Function
1	Current Error Analog Input
2	Measured Voltage Analog Input
3	Measured Current Analog Input
4	Current Setpoint Analog Input
5	Setpoint Analog Output
6	Input Shield
7	Input Return
8	Setpoint Shield
9	Setpoint Return

2.2.2 Digital Cable

a) Digital Outputs - There are sixteen digital outputs from the PSI to the power supply. They are designed to provide standard five volt TTL logic levels when terminated in the power supply by a 1KÙ resistor to digital ground. The power supply must provide these terminating resistors to digital ground. All outputs are TRUE high (TTL logical 1), except for OFF, which is TRUE low (TTL logical 0). This will cause the power supply to shut off if the PSI loses power.

b) Digital Inputs - There are sixteen digital inputs to the PSI from the power supply. They are designed to accept standard five volt TTL logic levels, and each will be terminated in the PSI by a 1KÙ resistor to digital ground. All outputs are TRUE high (TTL logical 1).

c) Connectors - All connectors are 37 pin standard D connectors, with gender as follows:

- On PSI: Female
- On PSI end of Cable: Male
- On Power Supply end of Cable: Male
- On Power Supply: Female

Connectors on both ends of the cable are to be supplied with strain relief back shells.

d) Pin Designations - The pin designations are given in Table 2. The interpretation of these signals may change as a function of power supply type, but the designations as input or output will not.

e) Cable - A shielded twisted 37 conductor cable joins the connectors.

Table 2. Digital Cable Pin Designation

Pin	Function	Pin	Function
1	On Command	20	Off Command
2	Standby Command	21	Reset Command
3	Negative Polarity Command	22	Spare Command #1
4	Spare Command #2	23	Spare Command #3
5	Spare Command #4	24	Spare Command #5
6	Spare Command #6	25	Spare Command #7
7	Spare Command #8	26	Spare Command #9
8	Spare Command #10	27	Spare Command #11
9	Digital Ground	28	Digital Ground
10	Digital Ground	29	Digital Ground
11	Digital Ground	30	On Status
12	Off Status	31	Standby Status
13	Negative Status	32	Fault Summary
14	Overvoltage	33	Overcurrent
15	Out of Regulation	34	Fan Fault
16	Overtemp	35	Water Flow Fault
17	Water Mat Fault	36	Security Interlock
18	Ground Fault	37	Ripple Fault
19	Phase Fault		

2.3 The PSC to PSI Connection

The PSC is connected to the PSI with a pair of fibers terminated in duplex connectors. Figure 3 shows the required materials, and the kit required to install the connectors on the fiber.

This connection is not normally done at the power supply manufacturer, but is made as part of installation. Pre-assembled cables are available to use for testing at the power supply manufacturer.

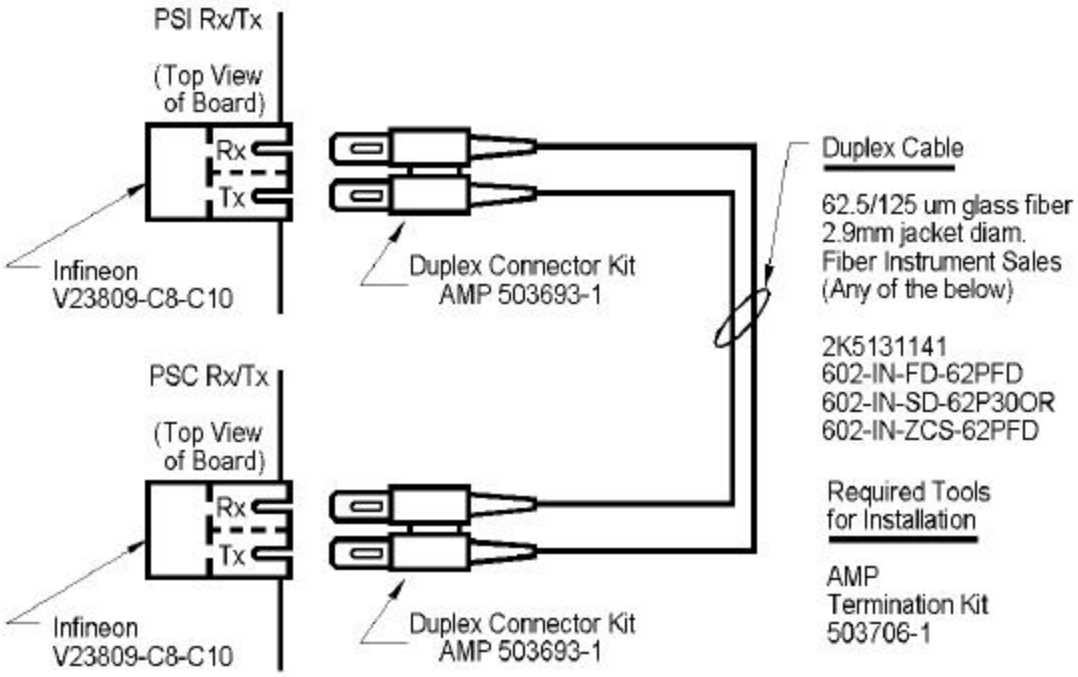

Figure 3 PSC to PSI Connection

2.4 PSC Connections

The PSC is normally used within a VME chassis. VME interfacing is not covered in this document. But, aside from the VME interface and the fiber connections described in section 2.3, there are additional connections to the PSC. First, there are a pair of trigger inputs for timing, and an RS-232 input.

2.4.1 Timing Inputs

a) Function - There are two timing inputs, one to initiate a read, and one to initiate a write. They have identical hardware requirements.

b) Isolation - The PSC provides isolation for the timing pulses, with a TLP2530 opto-isolator. The load seen by the timing pulses is the input LED of that device in series with 180Ù.

c) Connector - The right angle printed circuit card receptacle on the PSC is Lemo part number EPL.00.250.NTN. The cable used to interface with the PSC will typically be an RG316 coaxial cable terminated with a LEMO P/N FFC.00.250.NTCC27 connector.

2.4.2 RS232 Input

The RS232 input is used in place of the VME interface for testing purposes, when a VME based system is not available.

a) Signals - RS232 signal thresholds. 38400 baud, 8 data bits, 1 start bit, 1 stop bit, no parity.

b) Connector - Standard nine pin D connector.

c) Software - BNL will provide software will be provided to users of the PSC. The serial port protocol and memory mapping is not covered in this document.

2.5 Operational States and Commands

SNS power supplies have four operational states: ON, OFF, STANDBY, and FAULT. The power supply will change from one state to another in response to three commands: ON CMD, OFF CMD, STANDBY CMD, and one event: FAULT EVENT.

The operational status as a result of a command is show in Figure 4, State Diagram.

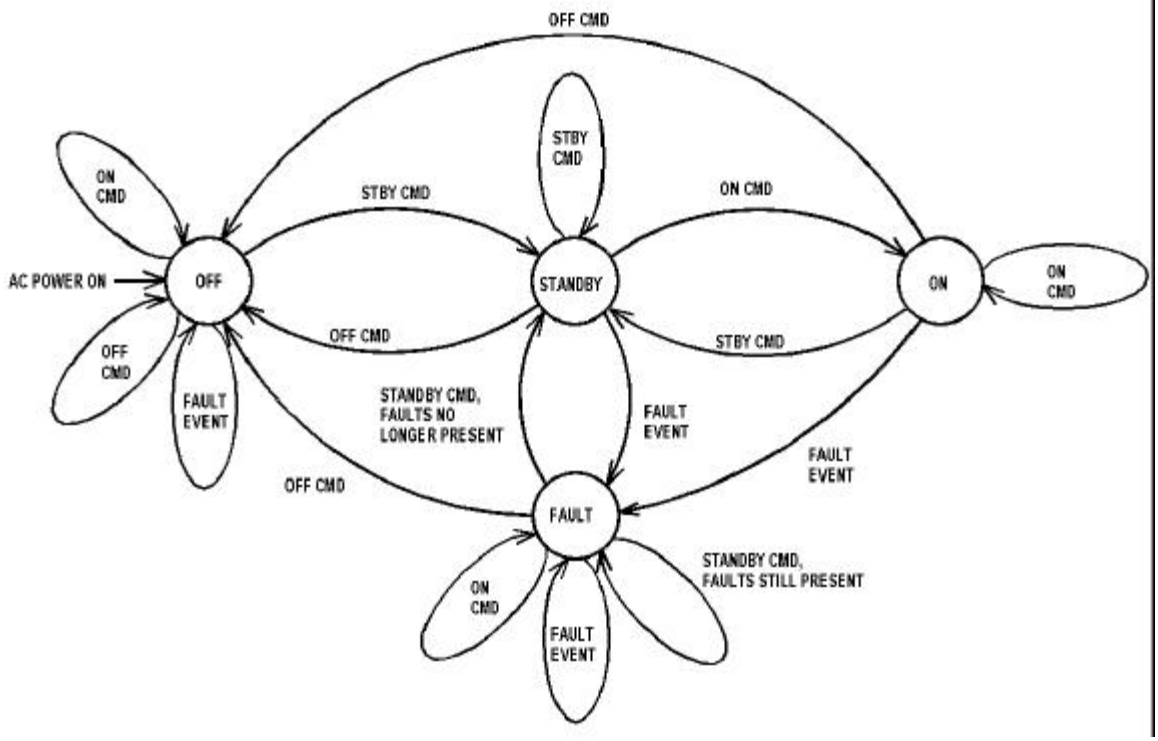

Figure 4 State Diagram

2.5.1 State Definitions

a) OFF

i. AC power is connected to the power supply.
ii. The main contactor is open, preventing AC power from being applied to the power stages of the unit (rectifiers, SCRs, transformer inputs). No power is delivered to the load.
iii. The fans are off.
iv. Internal control power, sufficient for the unit to respond to other commands and indicate state is available.
v. The OFF indicator is illuminated, and the OFF state is indicated as a status readback to the PSI.

When AC power is applied to the power supply, it shall automatically go into this OFF state.

b) Standby

i. AC power is connected to the power supply.
ii. The main contactor is open, preventing AC power from being applied to the power stages of the unit (rectifiers, SCRs, transformer inputs). No power is delivered to the load.
iii. The fans are on.
iv. Internal control power is applied to all circuit boards, including regulators and control circuitry.
v. The STANDBY indicator is illuminated, and the STANDBY state is indicated as a status readback to the PSI.

c) ON

i. AC power is connected to the power supply.
ii. The main contactor is closed, applying AC power to the power stages of the unit (rectifiers, SCRs, transformer inputs). The load is powered.
iii. The fans are on.
iv. Internal control power is applied to all circuit boards, including regulators and control circuitry.
v. The ON indicator is illuminated, and the ON state is indicated as a status readback to the PSI.

d) Fault

i. AC power is connected to the power supply.
ii. The main contactor is open, preventing AC power from being applied to the power stages of the unit (rectifiers, SCRs, transformer inputs). No power is delivered to the load.
iii. The fans are on.
iv. Internal control power is applied to all circuit boards, including regulators and control circuitry.
v. The STANDBY and FAULT indicators are illuminated, and the STANDBY state is indicated. The SUMMARY FAULT and individual faults are sent as status readbacks to the PSI.
vi. Fault events are latched in this state.

2.5.2 Commands and Faults

a) Command Definitions

The three commands shall change state as defined in Figure 4, State Diagram. Their polarity and general intent is defined here.

i. OFF CMD - This command is used to turn off the power supply for extended periods. This signal is normally high (5V), and is pulsed low (0V) to initiate this command.
ii. STANDBY CMD - This command has two functions. In normal operation, it puts the power supply in a standby state, and it is then ready to accept an ON CMD. When the power supply is in the fault state, this command is used to try to clear the latched fault. This signal is normally low (0V), and is pulsed high (5V) to initiate this command.
iii. ON CMD - This command is used to energize the power circuits and deliver power to the load. This signal is normally low (0V), and is pulsed high (5V) to initiate this command.

b) Timing

i. Commands shall be pulsed. A pulse width of less than 20 mSec shall never be accepted as a valid command. A pulse width of more than 200 mSec shall always be accepted as a valid command. The pulse width shall not exceed five seconds.

ii. Only one of the three commands can be active at any given time. In the case of a second command reaching the control system while a previous command is active, the control system will terminate the first command and initiate the second command.

c) Fault Event

i. FAULT EVENTS can occur at any time, and may come from internal or external sources. They effect the state of the power supply as defined in Figure 4, State Diagram.
ii. Fault indications are latched while the power supply is in the fault state. They are cleared as a result of the STANDBY CMD if the fault event no longer exists.

3.0 Personnel Protection System (PPS) Interface

3.1 Overview

The function of the PPS interface to the power supplies is to have the ability to drop out (de-energize) the main contactor of the power supply in a fail-safe manner. Positive indication of this de-energized state is sent back to the PPS by means of auxiliary contacts from the power contactor.

Power supplies whose output power rating is less than 5KW, shall not require the PPS interlock circuitry described in the other paragraphs of this section.

3.2 Interface Details

The elements of the PPS interface are shown in Figure 5.

3.2.1 Connector

The PPS interface connector on the power supply is Amphenol P/N 97-4102A-18-19S. This is a box mounted receptacle with ten female crimp pins. The pin designations for this connector are shown in Table 3.

3.2.2 Test Plug

A test plug, to permit operation of the power supply without the PPS, shall consist of a mating male nine pin “D” connector with pins 1 and 2 shorted and pins 3 and 4 shorted, and a backshell to assist handling. These test plug assemblies will be supplied with the power supplies, as described in the specification.

Figure 5 PPS Interface Elements

Table 3. PPS Connector Pin Designation

Pin	Function
A	+24 VDC
B	Contactor Coil: +24 VDC Side
C	Contactor Coil: +24 VDC Return Side
D	+24 VDC Return
E	Aux Contact 1 - Pin 1
F	Aux Contact 1 - Pin 2
G	Aux Contact 2 - Pin 1
H	Aux Contact 2 - Pin 2
J	Chassis Ground
K	Not Used

3.2 Alternate Configuration for High Power SCR Supplies

In the case of high power SCR power supplies, it is advantageous to remove gating to the SCRs prior to opening the main contactor. This is shown in Figure 6, Delayed PPS Configuration.

In this configuration, the MPS signal is derived from the PPS relay contact closure, so that system can be informed of the impending shut-down.

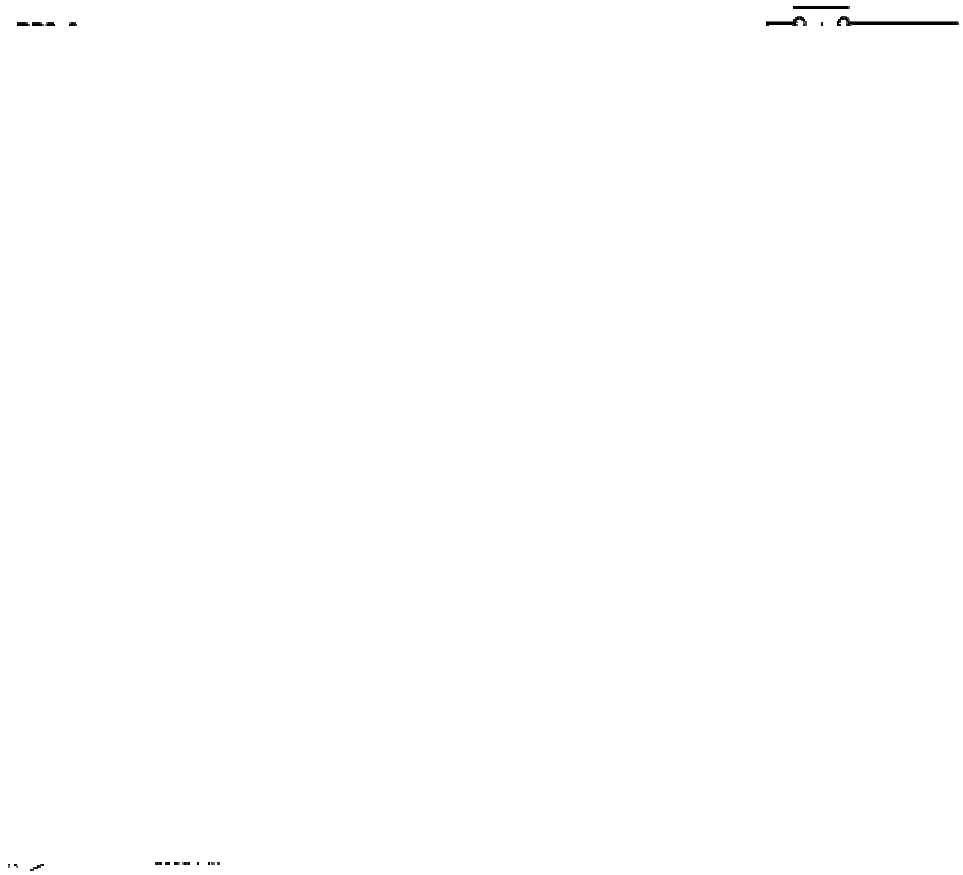

Figure 6 Delayed PPS Configuration

4.0 Machine Protection System (MPS) Interface

4.1 Overview

The function of the MPS interface described in this section, is to indicate when the power supplies has power to it's output leads. This will be derived from sensing the state of the power contactor.

4.2 Interface Details

The elements of the MPS interface are shown in Figure 7. Other implementations to effect this same function may be acceptable.

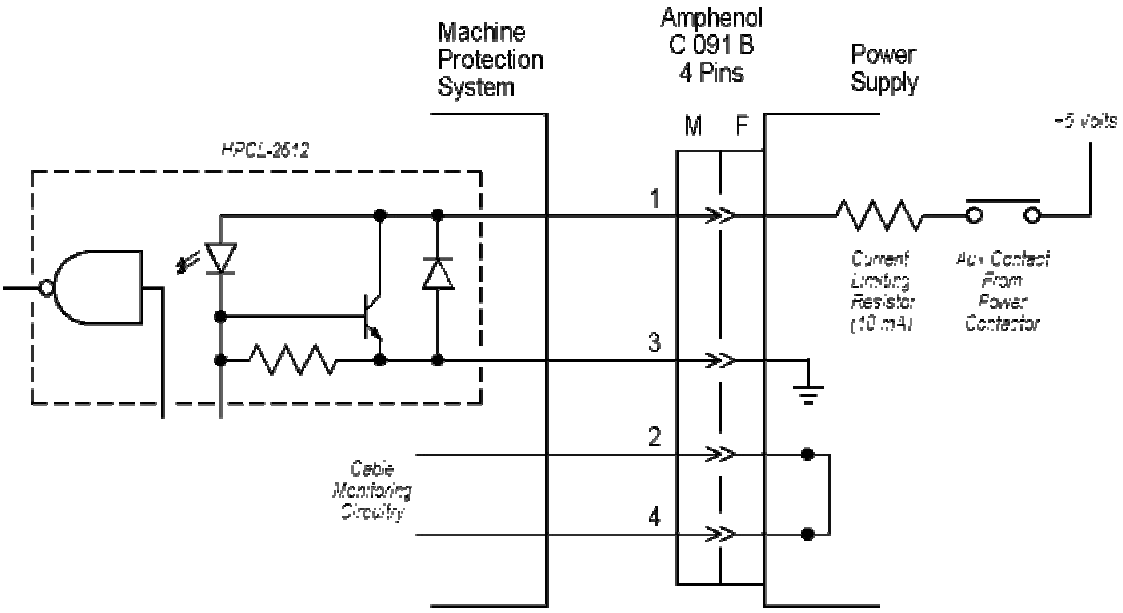

Figure 7 MPS Interface Elements

4.2.1 Connector

The MPS interface connector on the power supply is an Amphenol C 091 B 4 (four) pin connector, with IEC contact arrangement 130-9 with female gold plated crimp contacts.

4.2.2 Signal Levels

A TTL level HIGH signal capable of driving an HPCL2612 optocoupler (10 mA) is the input to the MPS, indicating that the supply is in the ON state.

5.0 Interlock / Fan Control Interface

5.1 Overview

A terminal block shall be provided on the power supply to accommodate wires for two purposes. The first of these is to accept interlock signals, such as magnet overtemp and magnet waterflow, that can shut down the power supply to protect itself and the equipment that is connected to the power supply.

The second function (for rack mountable power supplies) is to control the fan in the rack enclosure. If the power supply is not in the OFF mode, this control will energize the fan. In the case of multiple power supplies in a rack, these outputs may be put in parallel such that if any supply in the rack is not in the OFF mode, the fan will be energized. This case is shown in Figure 8.

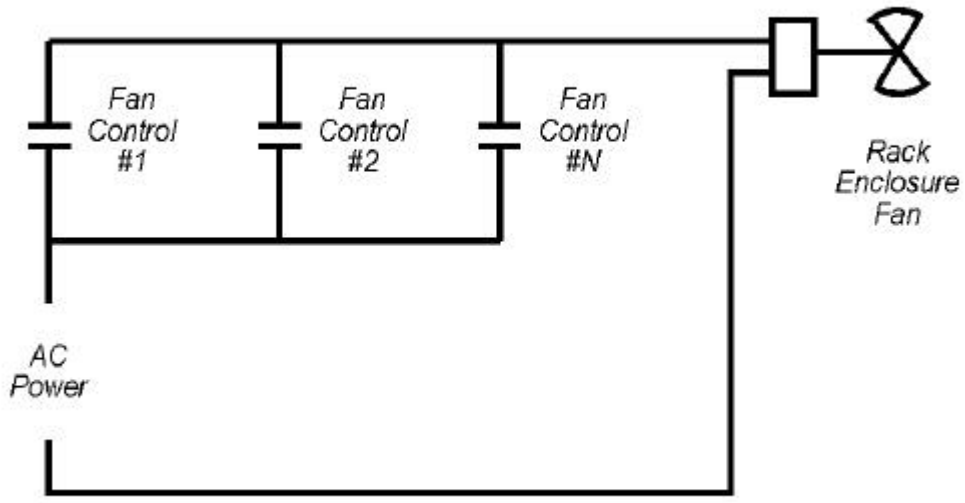

Figure 8 Fan Control with Multiple Supplies

5.2 Interface Details

The terminal block arrangement is shown in Table 4.

Table 4. Interlock / Fan Control Terminal Block Numbering

Pin	Function
1	Magnet Overtemp
2	Magnet Overtemp
3	Rack Airflow
4	Rack Airflow
5	Magnet Water Flow
6	Magnet Water Flow
7	Other External Interlock
8	Other External Interlock
9	Fan Control
10	Fan Control

5.2.1 Terminal Block

a) Dead Front - The terminal block selected shall not present a shock hazard from accidental contact.

b) Shipping / Testing Jumpers - The power supply will be shipped with all interlock connections shorted with a jumper. These will be removed after installation.

c) Wire Range - The terminal block shall be able to accommodate wires in the range of AWG #22 to AWG #16.

5.2.2 Interlock Inputs

a) Operation - The interlock inputs will be connected to a normally closed dry contact. When this contact opens, it will cause the power supply to go into the FAULT mode as described in the power supply specification.

b) Signal Levels - The contacts for these inputs are typically 1,000 feet away from the power supply. The voltage that appears on an open contact shall not be more than 30 Volts, but not less than 15 Volts. The current through a closed contact shall not be more than 100 mA, nor less than 10 mA.

5.2.3 Fan Control Outputs

a) Operation - The fan control contacts will be open if the power supply is in the OFF mode. The fan control contacts will be closed in any other mode.

b) Contact Rating - The contacts will be rated for 120 VAC, 15 Amps.